

## IODINE CONTENT AND PESTICIDE RESIDUES OF SOME NIGERIAN FOOD GRAINS

Etonihu A. C<sup>1</sup>., Aminu B. A<sup>1</sup>., Ambo A. I<sup>1</sup>., Etonihu K. I<sup>2</sup>

<sup>1</sup>Chemistry Department, Nasarawa State University, PMB 1022, Keffi, Nigeria, <sup>2</sup>Department of Agric. Economics & Extension, Nasarawa State University, Lafia Campus

### ABSTRACT

Samples of some Nigerian food grains (white maize, white beans and sorghum) were purchased randomly from open markets in Nasarawa and Plateau States. Using gas chromatography and titrimetry, the samples were analyzed for pesticide residues and nutritional iodine contents. The results showed a slightly higher residue level in the bean samples from Keffi market ( $54.68 \times 10^{-3}$  mg/kg) than bean samples from Akwanga ( $54.14 \times 10^{-3}$  mg/kg). While aldicarb residue was lowest concentration ( $0.28 \times 10^{-3}$  mg/kg), DBCP had the highest residual concentration ( $3.64 \times 10^{-3}$  mg/kg). When compared to the WHO, FAO, and the reports in literature, the pesticide residues in these samples appeared to be lower. Consequently these food grains, at the moment, do not pose health risk to the consumer. The iodine contents of the sample ranged from 68.8 mg/kg (for Keffi bean samples) to 89.9 mg/kg (for Mararaba maize samples). High nutritional iodine in food samples is important for good health.

**KEYWORDS:** food grains, iodine, Nigeria, pesticide residue

### INTRODUCTION

Pesticides are chemical substances defined as poisons and used in certain circumstances to kill specifically targeted pests (Ahren, 1994). These highly stable compounds can last for years and decades before breaking down. They circulate globally, and persistent pesticides released in one part of the world can be transported through a repeated process of evaporation and deposit through the atmosphere to regions far away from the original source (Curran, 2001).

Although the benefits of pesticides cannot be overstated, their use raises a number of environmental concerns such as potential toxicity to humans and other animals (Kamrin, 1997). Over 98% of sprayed insecticides and 95% herbicides reach a destination other than their target species, including non-target species, air, water and soil. Pesticides are one of the causes of water pollution; some are persistent organic pollutant and contribute to soil contamination (Bradman, 1999).

Pesticides are toxic in nature and do not differentiate between targeted and non-targeted species, and hence should essentially be subject to safe and judicious use. Due to injudicious and indiscriminate use of pesticides, many accidents have occurred in different parts of the world and presence of pesticides in foods, fruits, vegetables and even in mother's milk is a matter of grave concern (WHO, 2002). Of all the pesticides released into the environment every year by human activity, persistent pesticides are among the most dangerous. They are highly toxic, causing an array of diverse effects, notably death, diseases and birth defects among human and animals. Specific effect can include cancer, allergies and hypersensitivity, damage to the central and peripheral nervous systems, reproductive disorders, and disruption of the immune system (Strong *et al.*, 2004).

The World Health Organization and the UN environment programmes estimate showed that each year, 3 million workers in agriculture in the developing countries experience severe poisoning from pesticides, resulting to about 18,000 deaths; while about 25 million workers suffer mild pesticide poisoning (Jaga, 2003; FAO, 2002). Many studies indicated that pesticide exposure is associated with long term health problems such as respiratory problems, depression, miscarriage, acute toxicity and birth defect (Lee, 2006).

Seventy-five percent of all pesticides in the world are used in developed countries, but use in developing countries is increasing (Lee, 2006). Many food crops including fruits and vegetables contain pesticides residue after being washed or peeled. The EPA sets the tolerance based on the toxicity of the pesticides and its breakdown products, the amount and frequency of pesticide residue in food by the time it is marketed (FAO,

2002). Exposure routes other than consuming food containing residues, in particular pesticide drift, are potentially significant to the general public (Kamel, 2003).

There is a dearth of information of pesticide residues in foodstuffs marketed in Nigeria. In recent times, there have been reported cases of food poisoning and deaths related to pesticide remnants in food materials. This work seeks to determine the content of nutritional iodine and pesticide residues in the samples of some marketed Nigerian food grains in order to assess their potential health risks and create public health awareness to consumers.

## MATERIALS AND METHODS

### Samples Collection

Samples of white maize, white beans and sorghum were purchased randomly from markets in Mararaba, Keffi, Akwanga and Lafia in Nasarawa State and Jos in Plateau State. Three different samples of maize, beans and sorghum were purchased from each of these five different markets to give a total of fifteen samples.

### Sample Treatment

The samples were cleaned of unwanted solid particles. Each sample was ground into a fine powder using a mortar and pestle, properly labeled and stored for further analysis.

### Determination of Percent Moisture Content

The powder sample (10g) was oven dried at 100°C for 30 minutes, cooled in a desiccator and reweighed. The procedure was repeated until a constant weight and the difference in weight loss was calculated as percent moisture content.

### Determination of Iodine Content

Each powder sample (10g) was dissolved in 30cm<sup>3</sup> distilled water in 250 cm<sup>3</sup> volumetric flask with a stopper. The sample solution was made up to 50cm<sup>3</sup> with distilled water to which 1mL of 1M H<sub>2</sub>SO<sub>4</sub> and 5cm<sup>3</sup> of 10% potassium iodide were added. Colour change to yellow indicated the presence of iodine. Using titrimetry method, a clean burette with 0.005M Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub> was titrated against the grain sample solution in the flask until the solution turned pale yellow. To this solution was added 2cm<sup>3</sup> of starch indicator and colour changed to dark purple. The titration was continued until the solution turned colourless that indicated the end point and final burette reading (Jacobs, 1983). Using the conversion table the titre value (in cm<sup>3</sup>) was converted to the equivalent iodine content in mg/kg (NIS/ SON, 2004).

### Extraction of Pesticide Residue

The powder sample (100g) was extracted using benzene at 80°C for 6 h in a Soxhlet extractor in order to isolate pesticide from fats (Jacobs, 1983). The extract from the Soxhlet extraction was concentrated to 50g and transferred into a clean 500cm<sup>3</sup> beaker, to which was added 1L of carbon tetrachloride and 1L of 95% ethyl alcohol, and shaken vigorously for 1h in order to remove water content. 100g of anhydrous Na<sub>2</sub>SO<sub>4</sub> was added. The liquid phase was transferred to a 500cm<sup>3</sup> separatory funnel to which 200cm<sup>3</sup> of water was added, and shaken vigorously for 2 to 3 minutes to allow the phases to separate. The aqueous phase was drained off and the process was repeated. In the first rinse, the aqueous phase contained about 30% alcohol in which CCl<sub>4</sub> was soluble only to about 1%. The various insecticides distributed themselves in favour of CCl<sub>4</sub>, which contained only about 3% alcohol. This small amount of alcohol was removed by the second rinse, since virtually all the pesticides were concentrated in CCl<sub>4</sub>. This extract was subjected to pesticide analysis by gas chromatography.

### Determination of Pesticide Residues by Gas Chromatography

The extracts of the beans samples from Keffi market (KFBS) and Akwanga market (AKBS) were subjected to gas chromatography using HP 6890 Gas Chromatograph powered with HP ChemStation Rev. A09.01 [1206] software. The conditions of the gas chromatography analysis were as follow: hydrogen carrier gas with inlet temperature of 250°C and flow rate of 1.0 ml/min, a PFPD detector of temperature 300°C, and column dimension of 30 m x 0.25 mm x 0.25 µm.

## RESULTS AND DISCUSSION

Table 1 showed that percent moisture varied among the food grains from 1.01% (for Mararaba maize samples) to 11.0 % (for bean samples from Jos). Moisture content varied as follows: 2 % (in AKBS) to 11 % (in JOBS) for bean samples; 1 % (KFMS) to 10 % (LAMS) for maize samples; 2 % (in JOSS) to 10 % (in AKSS).

Moisture content determination in food is important because moisture provides a number of biochemical and physiological changes in food (FAO, 2002).

Table 1: Moisture and iodine contents of selected Nigerian food grains

S/N	Grain Identification	Moisture (%)	Iodine (mg/kg)
1	AKBS	2.0	76.2
2	AKMS	5.0	85.7
3	AKSS		10.0
4	JOBS		11.0
5	JOMS		3.0
6	JOSS		2.0
7	KFBS		8.0
8	KFMS	3.0	84.6
9	KFSS		5.0
10	LABS		10.0
11	LAMS	10.0	86.8
12	LASS		5.0
13	MABS	5.0	73.0
14	MAMS	1.0	89.9
15	MASS	5.0	84.6

AK = Akwanga; JO = Jos; KF = Keffi samples; MA = Mararaba; LA = Lafia.

BS = Bean Sample; MS= Maize Sample; SS = Sorghum Sample.

Nutritional iodine was highest for maize samples from Mararaba (89.9 mg/kg) but lowest for the Keffi bean samples (68.8 mg/kg). The nutritional iodine ranged as follows: 68.8 (in KFBS) to 76.2 mg/kg (in AKBS) for bean samples; 84.6 (in KFMS) to 89.9 mg/kg (in MAMS) for maize samples; 79.4 (in KFSS) to 85.7 mg/kg (in LASS) for sorghum samples. The nutritional iodine contents of these samples were comparable to the iodine contents of edible salt deposits of parts of Nasarawa State of Nigeria that ranged from 37.1 to 246.7 mg/kg (Etonihu *et al.*, 2009).

Table 2 showed that the concentration of pesticide residues in AKBS ranged from  $0.27 \times 10^{-3}$  mg/kg (for aldicarb) to  $3.64 \times 10^{-3}$  mg/kg (for DBCP) and a total sum of  $54.14 \times 10^{-3}$  mg/kg of the pesticides in the bean samples from Akwanga.

Table 2: Concentrations of pesticide residues in AKBS (in mg/kg)

S/N	Pesticide	Amount per Area ( $\times 10^{-5}$ )	Amount ( $\times 10^{-3}$ mg/kg)
1	Mollinate	5.63	1.76
2	Aldicarb	0.02	0.27
3	2,4,6-trichlorophenol	0.12	1.35
4	MCPA	1.62	2.91
5	Simazine	4.59	2.61
6	Isoproturon	3.27	2.00
7	Chlorotoluron	1.24	0.85
8	Mecoprop	4.36	2.64
9	Atrazine	2.79	2.44
10	2,4 - D	0.89	1.32
11	Carbofuran	0.39	1.20
12	Terbuthylazine	0.38	1.48
13	Dimethoate	0.65	2.91
14	Dichloroprop	0.55	2.89
15	DBCP	0.52	3.64
16	Cyanazine	0.55	3.23
17	Pentachlorophenol	0.37	2.18
18	Fenoprop	0.51	0.90
19	Alachlor	1.27	2.80
20	2,4 - DB	1.17	2.46
21	Pendimethalin	0.33	1.14
22	Metolachlor	0.30	1.11
23	Lindane	0.38	0.85
24	Trifluralyrixyfen	1.51	2.19
25	Methoxychlor	1.14	2.23
26	Chlorpyrifos	3.76	1.44
27	DDT	6.46	2.51
28	Aldrin	16.47	0.83
			$\Sigma = 54.14$

Long-term exposure to most pesticides could precipitate serious health problems, which may manifest months or years later. The effect of pesticides such as organochlorine (OC), organophosphorus (OP), carbamates may cause cancer, tumors, birth defects, blood disorders (Strong *et al.*, 2004).

Table 3 showed the concentration of various pesticides in the food grains from Keffi market. The pesticide residues ranged from  $0.28 \times 10^{-3}$  mg/kg (for aldicarb) to  $3.64 \times 10^{-3}$  mg/kg (for DBCP). The total sum of the residues in the sample from Keffi market when compared with the threshold of 0.005 mg/kg by the WHO (2002) guideline, aldicarb residue in bean samples from Akwanga and Keffi were lower, so may not be harmful to the health of consumers. The 2,4,6-trichlorophenol residue ( $1.35 \times 10^{-3}$  mg/kg) in these samples could favourably be compared with the values of 0.03 mg/kg reported by Jaga (2003) for 2,4,6-trichlorophenol.

Similarly, the lower concentrations of  $2.93 \times 10^{-3}$  mg/kg (for MCPA) and  $2.18 \times 10^{-3}$  mg/kg (for pentachlorophenol) could be comparable with the value of 0.10 mg/kg by Olshan and Daniels (1997). This indicated that these food grains were still safe for consumption. The concentrations of  $2.62 \times 10^{-3}$  mg/kg (for simazine) and  $0.92 \times 10^{-3}$  mg/kg (for fenoprop) were lower than 0.04 mg/kg recommended by FAO (2002).

The concentrations for isoproturon ( $2.02 \times 10^{-3}$  mg/kg) and alachlor ( $2.81 \times 10^{-3}$  mg/kg) were lower than the WHO (2002) recommendation of 0.1 mg/kg. The residues of  $0.87 \times 10^{-3}$  mg/kg (for chlorotoluron) and  $2.50 \times 10^{-3}$  mg/kg (for 2,4 - DB) were lower than the 0.5 mg/kg reported by Beselar *et al.* (2008).

The residues of  $2.66 \times 10^{-3}$  mg/kg (for mecoprop) and  $1.17 \times 10^{-3}$  mg/kg (for pendimethalin) in the bean samples were lower compared with the 1.00 mg/kg reported by Gorell *et al.* (1998). The concentrations of  $2.46 \times 10^{-3}$  mg/kg (for atrazine) and  $1.13 \times 10^{-3}$  mg/kg (for metolachlor) were lower compared with the 0.01 mg/kg reported by Reuber and Ritter (1981).

Table 3: Concentration of Pesticide Residues in KFBS (in mg/kg)

S/N	Pesticide	Amount per Area ( $\times 10^{-5}$ )	Amount ( $\times 10^{-3}$ mg/kg)
1	Mollinate	2.98	1.78
2	Aldicarb	0.02	0.28
3	2,4,6-trichlorophenol	0.08	1.37
4	MCPA	0.62	2.93
5	Simazine	1.75	2.63
6	Isoproturon	10.12	2.02
7	Chlorotoluron	1.61	0.87
8	Mecoprop	13.59	2.66
9	Atrazine	14.52	2.46
10	2,4 – D	10.01	1.34
11	Carbofuran	1.37	1.21
12	Terbuthylazine	2.12	1.50
13	Dimethoate	1.62	2.93
14	Dichloroprop	1.32	2.91
15	DBCP	1.03	3.64
16	Cyanazine	0.97	3.25
17	Pentachlorophenol	0.62	2.18
18	Fenoprop	0.36	0.92
19	Alachlor	0.73	2.81
20	2,4 – DB	0.70	2.50
21	Pendimethalin	0.40	1.17
22	Metolachlor	0.37	1.13
23	Lindane	0.40	0.87
24	Trifluralyrixyfen	1.86	2.21
25	Methoxychlor	1.09	2.25
26	Chlorpyrifos	3.90	1.47
27	DDT	18.99	2.55
28	Aldrin	21.99	0.85
			$\Sigma = 54.68$

The concentrations of  $1.21 \times 10^{-3}$  mg/kg (for carbofuran) and  $2.21 \times 10^{-3}$  mg/kg (for trifluralyriproxyfen) were lower compared with the 0.40 mg/kg reported by Rohlman *et al.* (2006), and the 0.10 mg/kg reported by Jiwan (2008) for maximum residues limits (mrls) in the food commodities in Nepal. The concentrations of  $1.50 \times 10^{-3}$  mg/kg (for terbuthylazine) and  $2.25 \times 10^{-3}$  mg/kg (for methoxychlor) were lower compared with the 0.001 mg/kg reported by Hoppin *et al.* (2008).

The concentrations of  $2.93 \times 10^{-3}$  mg/kg (for dimethoate) and  $1.47 \times 10^{-3}$  mg/kg (for chlorpyrifos) were lower compared with the 0.002 mg/kg WHO (2006) recommended. The concentrations of  $2.91 \times 10^{-3}$  mg/kg (for dichloroprop) and  $2.55 \times 10^{-3}$  mg/kg (for DDT) were lower compared with the 0.5 mg/kg standard by FAO (2002). Jiwan (2008) had reported higher residue levels of 0.05 mg/kg for chlorpyrifos and 1.00 mg/kg for dichloroprop for food grains in Nepal. The concentrations of  $1.78 \times 10^{-3}$  mg/kg (for mollinate) and  $0.85 \times 10^{-3}$  mg/kg (for aldrin) were lower compared with the 0.1mg/kg reported by Vanderlee *et al.* (2008).

## CONCLUSION

The bean samples from Keffi market showed a slightly higher pesticide residue ( $54.68 \times 10^{-3}$  mg/kg) than the Akwanga bean samples ( $54.14 \times 10^{-3}$  mg/kg). In both cases, aldicarb had the lowest concentration ( $0.28 \times 10^{-3}$  mg/kg) while DBCP had the highest concentration ( $3.64 \times 10^{-3}$  mg/kg). When compared to the WHO, FAO, and the reports in literature, the pesticide residues in these samples appeared to be lower. Consequently these food grains, at the moment, do not pose health risk to the consumer. The iodine contents of the samples ranged from 68.8 mg/kg (for Keffi bean samples) to 89.9 mg/kg (for Mararaba maize samples). High nutritional iodine in food samples is important for good health.

## RECOMMENDATIONS

- i. Governments at all levels should encourage the use of safer insecticide or herbicide application on farmlands and food grain storages.
- ii. Government should set up a task force that would regularly test and monitor the various food grains in Nigerian markets in order to ascertain their levels of pesticide residue.
- iii. There should be a health enlightenment programme to enlighten citizens on the effects of pesticide residues in order to curb the potential health risk to consumers.

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Received for Publication: 22/03/2011

Accepted for Publication: 30/04/2011

Corresponding Author

Etonihu A. C

Chemistry Department, Nasarawa State University, PMB 1022, Keffi, Nigeria

Email: criseto@yahoo.com